1,065,463

PATENT SPECIFICATION

DRAWINGS ATTACHED

1,065,463

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Int. Cl.:—H 01 s 3/22

COMPLETE SPECIFICATION

Improvements in or relating to Devices for and methods of producing Stimulated Radiation Emission by Utilising Flame Reactions

We, PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED, of Abacus House, 33 Gutter Lane, London, E.C.2., a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to devices for and methods of producing stimulated optical radiation emission by utilising flame reactions. Thus population inversion is directly produced in a flame.

It has already been proposed to produce, in chemically reacting gases, a population inversion between two electron energy levels so that stimulated emission of infra-red radiation becomes possible. However, this was proposed for gases which have previously been converted into the active (dissociated) condition, for example by means of an electric discharge.

It is known that such a population inversion between higher molecular rotation levels of one of the intermediate products present can occur in a reacting mixture of atomic nitrogen and methylene chloride so that stimulated emission of micro-wave energy would be possible as a result.

It is an object of the invention to provide a device by means of which stimulated emission of radiation can be obtained.

The invention provides a device for producing stimulated optical radiation emission by utilising a flame reaction, said device comprising a gas reaction chamber inside an optical resonator for the radiation, and a gas inlet to said chamber situated with its orifice arranged substantially parallel to the optical axis of said resonator and means for feeding fuel gases containing carbon and hydrogen in a neutral condition through said inlet to said chamber at such pressure and in such quantities that energy released by the flame reaction results in a population inversion between first and second electron energy levels in the gases present or formed in said reaction chamber so that stimulated emission of radiation occurs in operation.

The invention also provides a method of producing a beam of optical radiation by stimulated emission utilising a flame reaction, said method including the step of feeding fuel gases containing carbon and hydrogen in a neutral condition to a gas reaction chamber inside an optical resonator via a gas inlet situated with its orifice arranged substantially parallel to the optical axis of said resonator, the said gases being fed to said chamber at such pressure and in such quantities that energy released by the flame reaction results in a population inversion between first and second energy levels in the gases present or formed in said reaction chamber so that stimulated emission of radiation occurs to produce an output radiation beam.

The term "optical radiation" used herein includes infra-red and ultra-voilet radiation.

Flame reactions are to be understood herein to include all self-supporting reactions in gas mixtures which occur with the production of energy to give the desired result, of which the combustion of a gas with air or oxygen is an example.

In order to obtain an optically homogeneous reaction zone and, to restrict as must as possible the disturbing influence of collisions between gas molecules, the pressure of the reacting gases is preferably between 1 and 50 mm of mercury.

The ignition of the gases may be effected by means of a high frequency discharge in the gas inlet which discharge, however, is ended

[*Price 4s. 6d.*]

after ignition of the flame. This contrasts with the aforementioned prior proposals in which a supply of excited gases was used.

The reaction gases may be supplied separately, or a mixer may be provided for mixing the fuel gases prior to their entry into the reaction chamber.

A suitable fuel gas is a mixute of acetylene with oxygen. This gives strong emission bands in the near ultra-violet region and in the visible region of the spectrum.

The fuel gases may include gaseous metal compounds in addition to hydrogen and carbon so that the metal atoms can be brought to the state of population inversion by impacts with high energy molecules.

An atomiser, known *per se*, may be provided for atomising a solution of metal compounds in the fuel gases. These metals and those mentioned above may comprise a transition metal or a rare earth.

In order that the invention may readily be carried into effect, one embodiment thereof will now be described in greater detail, by way of example, with reference to the accompanying diagrammatic drawing.

The Figures of this drawing show two different cross-sections of such a device.

In Figures 1 and 2, reference numeral 1 is a cylindrical reaction chamber having a diameter and a length of, for example, 40 cm. The reaction chamber is provided with two quartz windows 2 on narrow tubular extensions 3, so that they are positioned away from the flame. The windows are preferably arranged at the Brewster angle with the axis of the optical resonator, which is formed by two mirrors 4. Acetylene and oxygen are fed separately to the chamber through two glass gas inlet tubes 5, which are provided with orifices 6, for example 20 cm long and 0.5 cm wide arranged substantially parallel to the axis of the resonator. These fuel gases are fed, for example from a cylinder, at a pressure such that the pressure in the chamber is maintained at approximately 10 mm of mercury by means of a pump connected to an exhaust pipe 7.

With a supply of 20 cm^3 of acetylene per second at 1 atmosphere pressure, and with complete combustion thereof, strong emission bands occur in the radiation observable in the optical resonator, *inter alia* at wavelengths near 3900, 4300, 4700, 5100 and 5600 ÅU. This radiation originates from CH-groups and double-bonded carbon atoms. Also bands occur at wavelengths near 2800 and 3100 ÅU. This radiation originates from OH-groups. The light in one or more of these wavelength bands may be obtained as an output beam in known manner, for example by making one or more of the mirrors 4 partly transparent.

WHAT WE CLAIM IS:—

1. A device for producing stimulated optical radiation emission by utilising a flame reaction, said device comprising a gas reaction chamber inside an optical resonator for the radiation the gas inlet to said chamber situated with its orifice arranged substantially parallel to the optical axis of said resonator and means for feeding fuel gases containing carbon and hydrogen in a neutral condition through said inlet to said chamber at such pressure and in such quantities that energy released by the flame reaction results in a population inversion between first and second electron energy levels in the gases present or formed in said reaction chamber so that stimulated emission of radiation occurs in operation.

2. A device as claimed in Claim 1, wherein means are provided for causing the pressure of the reacting gases to lie in the range 1 to 50 mm of mercury.

3. A device as claimed in Claim 1 or 2, wherein means are provided for mixing said gases prior to their entry into the reaction chamber.

4. A device as claimed in any of Claims 1, 2 or 3 wherein said fuel gases comprise acetylene and oxygen.

5. A device as claimed in Claim 1, 2, 3 or 4 wherein said fuel gases include gaseous metal compounds.

6. A device as claimed in any of Claims 1 to 4 including means for atomising a solution of metal compounds in said fuel gases.

7. A device as claimed in Claim 5 or Claim 6, wherein said metal comprises a transition metal or rare earth.

8. A device for producing stimulated light emission by utilising a flame reaction, substantially as herein described with reference to the accompanying drawing.

9. A method of producing a beam of optical radiation by stimulated emission utilising a flame reaction, said method including the step of feeding fuel gases containing carbon and hydrogen in a neutral condition to a gas reaction chamber inside an optical resonator via a gas inlet situated with its orifice arranged substantially parallel to the optical axis of said resonator, the said gases being fed to said chamber at such pressure and in such quantities that energy released by the flame reaction results in a population inversion between first and second energy levels in the gases present or formed in said reaction chamber so that stimulated emission of radiation occurs to produce an output radiation beam.

10. A method as claimed in Claim 9 wherein said fuel gases are at a pressure in the range of 1 to 50 mm. of mercury in said chamber.

11. A method as claimed in Claim 9 or Claim 10 wherein said fuel gases are mixed prior to their entry into the reaction chamber.

12. A method as claimed in any of Claims 9, 10 or 11 wherein said fuel gases comprise acetylene and oxygen.

13. A method as claimed in any of Claims 9 to 12 wherein gaseous metal compounds are mixed with said fuel gases.

14. A method as claimed in any of Claims 9 to 12 wherein a solution of metal compounds is atomised in said fuel gases.

15. A method as claimed in Claim 13 or Claim 14 wherein said metal comprises a transition metal or rare earth.

16. A method of producing a beam of optical radiation by stimulated emission utilising a flame reaction substantially as described with reference to the accompanying drawing.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

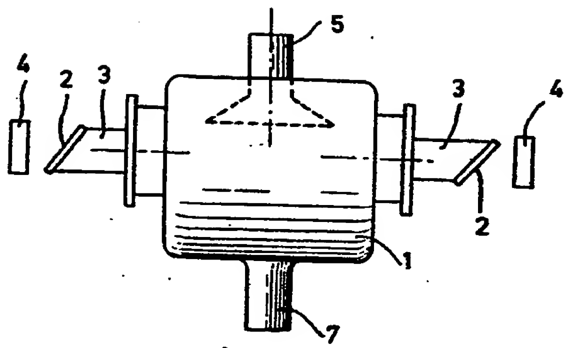

FIG.1

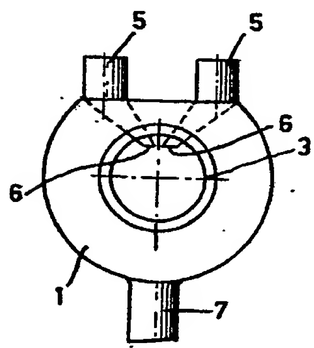

FIG.2